UNDERSTANDING ENERGY POVERTY - CASE STUDY: TAJIKISTAN

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Abstract: Access and affordability to energy services determine the state of energy poverty; however, there is no widely applicable definition of energy poverty and no universal set of measures for its eradication exists. This paper offers a new definition and possible solution for decrease, and eventually eradication, of energy poverty for the specific case of Tajikistan. As eradication of energy poverty needs to go in hand with nature preservation and economic development, authors provide possible approach to decrease of energy poverty in Tajikistan while simultaneously preserving nature and boosting the local economy.

Keywords: energy poverty, renewables, Tajikistan

1 INTRODUCTION

There are about 1.5 billion people in developing countries without access to electricity and 2.5 billion people who are dependent on traditional biomass fuels for cooking and heating [1]. It is often considered that those 1.5 billion people are living in energy poverty. However, energy poverty is a complex term. The simplest definition of energy poverty says that energy poverty equals lack of access to the energy services [2], whereas fuel poverty is most often defined as not being able to keep the household adequately warm at a reasonable cost [3]. However, it seems that energy poverty actually differs depending on circumstances in areas, people's preferences and lifestyles. This article will look into varying aspects of energy poverty (fuel poverty) with the aim to determine what the term energy poverty represents, whether it can be universally defined and how it can be eradicated. Tajikistan will be used as a case study to explore these questions and to bring understanding to correlation among varying factors underlying the country's development.

1.1 DEFINING ENERGY POVERTY

There is a whole range of various definitions of energy poverty and fuel poverty, some of which distinguish between those two terms, and others consider them to be equal. While some, as the World Economic Forum, define energy poverty as the *lack of access to sustainable modern energy services and products* [2], others, define energy poverty (in some cases referred to as fuel poverty) as *the inability to cover basic energy costs to keep homes adequately warm, cook food and have light.* It is also defined that cases of energy poverty occur if *household energy costs are above 10% of disposable income, transport fuels not included* [4].

The ”European Fuel Poverty and Energy Efficiency” defines fuel poverty as the *household's difficulty, sometimes even inability, to adequately heat its dwelling, at a fair price* [5]. The only EU country with a clearly defined framework for fuel poverty is UK, where *fuel poor* household is defined as one which needs to spend more than 10% of its income on all fuel use and to heat its home to and adequate standard of warmth [6].

It can be argued that defining the energy poverty as the *lack of access to sustainable modern energy services and products* is not generally applicable and there is no universally applicable definition. If the voluntary refusal of access to sustainable modern services is considered, as is the case for some religious or ethnic groups such as Amish or Masaai, then it is clear that the lack of access does not have to be a case of poverty. The Maasai *are traditional pastoralists, who have been living in Northern Tanzania and Southern Kenya since around AD 500 (Galtay, ¸986 c.f.* [7]). (Most) of the Maasai have no access to electricity or running water, and they exist largely outside the cash economy of Kenya [7]. One of main Amish prohibitions is the use of electricity from public lines [8], and as the result of their religious views Amish widely shun most of modern services. Despite lacking many of the conveniences of the modern time, and even more, not meeting some of the basic human right criteria (access to safe drinking water, access to sanitation or to energy services), they are generally satisfied with their life. Biswas-Diener et.al. (2005) showed that Amish and Maasai are happy and are satisfied with their lifestyle (although not overwhelmingly so). Therefore it is evident that not in all cases is lack of access to energy services determinant of state of poverty. Traditional lifestyles may in some cases serve as a base for voluntary or inherited refusal of modern services, including energy.

To make things even more complicated, some individuals within those communities are not satisfied with their access to services [per.com.]; however, do not have options for a change. All this implies that there is no such thing as universally applicable definition of energy poverty. If individuals lack of energy usage or lack of money to afford its payment is a matter of traditional lifestyle, than it can be argued that they cannot be considered poor in the conventional sense where poor are those that require assistance, welfare and help in order to change their living conditions.

Also, as affordable warmth is often used as one of key energy poverty indicators, it is evident that it is not universally applicable as some areas do not have cold periods at all and have problems with excess heat rather than cold [9]. Furthermore, using a fixed percentage of income spent on energy services as the threshold for energy affordability has to be done with some caution as the definition of households income may vary and may lead to misinformed results. More so, developing countries often have significant portion of income coming from remittances and other sources and private transfers that will not be available in official income statistics [10]. Considering all the facts and insecurities it is clear that terms such as energy or fuel poverty (or poverty) have to be used with caution.

In addition to the aforementioned, there are many other definitions of both fuel and energy poverty, and in some cases the distinction between energy poverty and fuel poverty is clear while in other case those two terms are often mixed.

Thus, for the purpose of this article, the energy poverty will be defined as:
Household's inability to afford and/or access the basic energy services, in the cases where desire to have those services exist, where the basic energy services are considered to be as follows:

- *household lighting,*
- *household heating,*
- *household cooking,*

and create a total demand of approximately 3kW per household. It is considered that approximately 100W per household is sufficient for lighting (5 CFL lightbulbs of 20W each), 1900kW for heating and 1000kW for cooking. All these numbers are considered in the specific case where only electricity is used for all purposes: lighting, heating and cooking.

Affordability will in this case be defined as the *share of utility payment in total household expenditure* [11]. As Fankhauser and Tepic (2007) argue, for developing countries share of energy costs in income is usually not the adequate measure of energy poverty, as main source of income is often informal. Thus it can be argued that share of energy services costs in total expenditure is in the case of Tajikistan a more reliable indicator of the energy poverty. Additionally, the issue that requires most urgent attention is the lack of access not the issue of affordability in most cases. Therefore, although it is highly recommended for the further studies to analyze the issue of affordability of energy in Tajikistan, for the reasons of scope this article will mainly focus on the issue of lack of access to the energy services.

An important assumption that was made was that approximately 100,000 households are most vulnerable and suffer from highest impacts of energy poverty in terms of limited or no access to energy services. Also it was assumed the targeted households are situated in the areas where there is diminishing availability of traditional biomass resources. That estimation was made based on the experience and was combined with the assumption that on average there is 10 inhabitants per household, including children. That same group is considered to fall below the affordability threshold. In support of this rough estimation goes the assessment of the World Bank where it was noted that in 2003 Tajiks were most likely to be poor (if they lived in GBAO or Khatlon, see FIGURE 1) if they were members of household with large number of children. Exact value of the affordability and vulnerability threshold falls out of the scope of this paper, and requires further extensive *on-site* research to provide accurate required data for further action.

1.2 BACKGROUND – TAJIKISTAN

Tajikistan became independent in 1991 as one of the former Soviet Union republics. Short upon gaining independence Tajikistan experienced a civil war which ended in 1997, and today Tajikistan remains the poorest country among the former Soviet Union sphere. Due to the lack of job opportunities a vital source of income for Tajikistan is coming from the remittances of the people working abroad, mostly in the Russia. More than 93% of country's land is mountainous and thus is not arable. Yet, two thirds of the population depend on agriculture for their livelihoods. Besides the remittances, aluminium and cotton exports are contributing to the economy. The population of Tajikistan is approximately 7.3 million of which 5.3 million live in rural areas. Although 73% of population is rural, people in rural areas are consuming only 8.58% of total electricity (See Table 1).

TABLE 1 **CONSUMPTION OF ELECTRICITY IN TAJIKISTAN IN URBAN AND RURAL AREAS***

Year	**2006**		**2007**		**2008**	
	kWh	%	kWh	%	kWh	%
Urban	1,841,137,710	13,49	1,786,097,913	12,79	1,744,547,432	13,94
Rural	**1,473,058,684**	**10,79**	**1,258,152,836**	**9,01**	**1,073,692,712**	**8,58**
Total population	3,314,196,394	24,28	3,044,250,749	21,80	2,818,240,144	22,52
Total consumed	13,651,676,973		13,966,707,650		12,514,921,593	

*Source: Barki Tajik sales department

Tajikistan is comprised of the following main regions (see FIGURE 1) [12] :

- Dushambe: capital – 9% of population
- Khatlon (comprising Kurban-Tube and Khulyab): agriculture- 36% of population
- Rayons of Republican Subordination (RRS): agliculture, aluminium industry – 22% of population
- Sughd: the most industrialized oblast – 30% of population
- Gorno-Badakhshan Oblast (GBAO): mountainous and remote – 3% of population

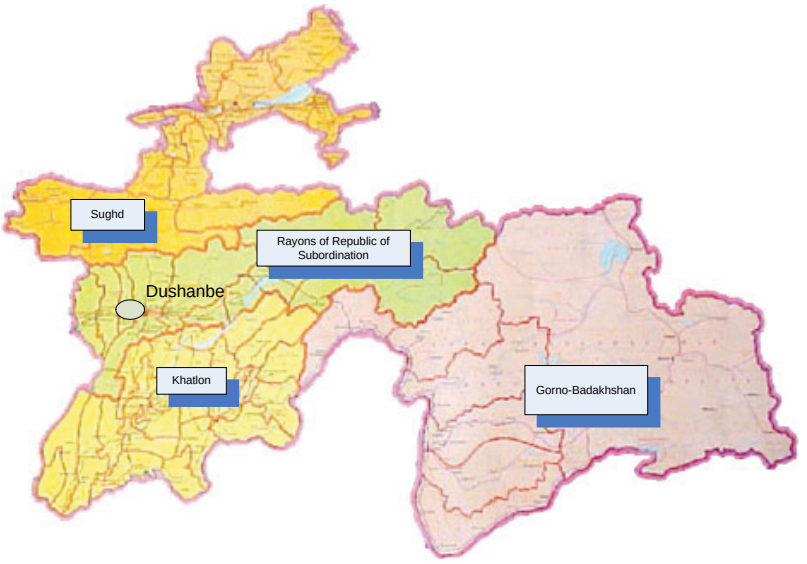

FIGURE 1 MAP OF TAJIKISTAN

In 2007 Tajikistan adopted the National Development strategy for the period until 2015 with the objective to reach Millennium Development Goals (MDGs). Tajikistan has already done some progress in reducing the energy poverty from 81% in 1999 to 53% in 2007, however, it is likely that as the result of current economic crisis the situation might have once again worsened [13]. It is also interesting to note, that despite the reported increase in standard (especially in the rural areas), people do not seem to notice much difference. Even more, significant share of already poor people considers their situation to have worsened (See Figure 2).

'Do you feel that your financial situation in the last 3 years has …?	Poorest 10%	Poorest 20%	Next 20%	Middle 20%	Next 20%	Richest 20%	All Taj
Improved a lot	2	2	1	4	3	5	3
Somewhat improved	10	14	21	22	26	30	23
Remained the same	54	54	57	57	51	48	53
Somewhat deteriorated	24	22	16	15	16	14	16
Deteriorated a lot	11	8	5	4	4	4	5
Total	100%	100%	100%	100%	100%	100%	100%

FIGURE 2 TAJIKS' VIEW OF THEIR FINANCIAL SITUATION (SOURCE: [8])

In Tajikistan there is limited, or no capacity to develop, and especially to implement poverty reduction policies. There is evidence of corruption at all levels of governance and cases of bribe are often reported [Freedom House (2003) c.f. [12]]. The donor community shows understanding and offers assistance for the financial aspect of poverty reduction. However, lack of understanding of the wide scope of the crisis in the country and situation in government, result with weak or nonexistent long-term effect of the financial help.

There is also evident lack of private investment. In the energy sector, where there is some private investments they have mostly been oriented on large scale hydro power plants, which would show benefits to the society in the longer term.

Tajikistan has excellent hydro potential, however large scale plants require longer time to be constructed and become operational. For those projects in the past it has not been the common practice to focus on using domestic products in the construction process or to use them as trigger for local communities' development. Having a good energy potential does not mean provision of instant solution to the energy poverty. However, if the wide scope of the crisis is understood, and realistic goals with economic welfare increase are set, the energy poverty can be reduced.

2 THE CASE OF ENERGY POVERTY – TAJIKISTAN

While in some cases lack of access to energy services may be completely voluntary, in Tajikistan lack of access to energy services is not voluntary and it can be considered as an indicator of energy poverty. The reasoning behind this statement is that while Tajikistan was still a part of Soviet Union, some regions were better off than today. At the time of Soviet Union electrification was one of top priorities, and in the 1980s per capita intensity-of-use coefficient was 4,000kWh per year, which was at the time better than in many European countries [14]. Today the existing infrastructure from Soviet time is deteriorating and there are no means to maintain it or repair it in the near future. Since the beginning of 21st century unscheduled disruptions of power supply have become a norm not only in Tajikistan, but also in the neighbouring Kyrgyzstan. For example Household Energy Survey conducted in Kyrgyzstan by World Bank in 2002 [15] reports the following facts:

- Only 26% of households have less than one service interruption per week
- Interruptions ranged from a few hours to 6-8 hours and more per day in some rural areas
- Scheduled power cuts are equally common and can last 12 hours per day
- Population complains about changes in network voltage. Some common examples from rural areas include inability to use refrigerators in the winter

because of insufficient voltage and some of respondents used candles for lighting because it was brighter than light bulb under the low voltage conditions

Another indication of deteriorating access and reliability of the grid has been the significant growth in distribution power networks' breakdown rate: in Kyrgyzstan there were 8,000 service interruptions in 1999; 10,000 in 2000 and 13,000 in 2001[16]. As the conditions in Kyrgyzstan are comparable to those in Tajikistan it is evident that there is significant increase in network breakdowns, especially if compared to the Soviet era for Tajikistan and the neighbouring countries.

The poverty became more evident because people have lost what they once had, especially as the country's economy was further weakened by the civil war. Although in some parts it has been observed that people did refuse international support and have chosen to remain isolated and living in poor conditions [17], it can be argued that majority Tajik people would like to be better off than they are today.

During the Tajikistan's Soviet era, some parts of the country have received support. One of those parts was GBAO which received considerable subsidies for energy, food and infrastructure [18]. As was the case with many other areas, as soon as the country declared its independence, those subsidies stopped to be available and the infrastructure started to deteriorate and eventually collapse.

The "shutting down" of the support source from Soviet Union was especially evident in Tajikistan's energy in remote areas. The Soviet Union provided energy supplies and there were decentralized diesel and hydro power plants which provided adequate supply [19].

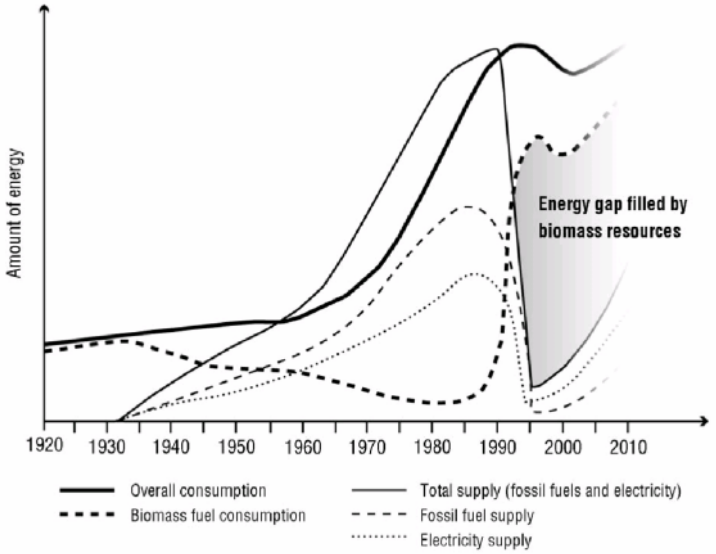

FIGURE 3 DEVELOPMENT OF ENERGY CONSUMPTION AND SUPPLY SINCE THE 1920s (SOURCE [6])

As can be seen on Figure 3, while the overall consumption continued to have mostly upward trend, the total supply had a sharp drop in the 1990s. This resulted in meeting the demand with traditional biomass leading to serious loss (almost 90%) of the forest cover. The loss of forest cover leads to increased vulnerability to soil erosion [20]. Breu et. al. argue that *as the result of the forced return of subsistence-*

oriented economy in a population that quadrupled since 1926, widespread signs of natural degradation can be observed. Deforestation and changes in the natural vegetation further lead to increased susceptibility to salinization which then decreases fertility of the land [21]. Both – salinization and soil erosion can have impact on the quality and accessibility of the drinking water, which then can have health consequences.

FIGURE 4 SHRINKAGE OF FEDCHENKO GLACIER IN THE PAMIRS OF TAJIKISTAN (SOURCE [13])

In the face of today's worries on the consequences of the climate change it is also important to keep in mind the loss of carbon sinks that manifests through extensive loss of forest cover and vegetation. Tajikistan depends heavily on the water from glacier and snow origin, and as the result of climate change that balance could be disturbed. Significant loss of glacier surface has been reported since 1930s and the loss rate has increased in second half of 20th century [22] (See Figure 4). Although Tajikistan's per capita emissions are extremely low Tajikistan will be impacted by the loss of glaciers which are main source of country's water, and thus should aim to preserve its carbon sinks (forest cover) to contribute to fighting climate change. Ultimately, if action is not done urgently, the forest cover could be lost completely having fatal consequences locally and globally. As the history has shown, societies that had unsustainably exhausted their natural resources are most likely to lead to self destruction unless alternatives are found [23].

When focusing on (energy) poverty, promoting and implementing sustainable energy (development) in Tajikistan is of vital importance if the land degradation, biodiversity loss, and carbon sinks are to be preserved. All those aspects manifest in availability of energy for consumption, availability of food and finally water, all of which are essential for healthy life and ultimately for development.

2.1 TAJIKISTAN'S CLOSED CIRCLE – ENERGY, FOOD AND WATER

Energy poverty cannot be singled out from other aspects of societal poverty. It is closely connected to other aspects of poverty such as food poverty and water poverty and with health condition. The energy-food-water (EFW) nexus shows the tight bonds among those three poverty indicators. Provision of energy (access and affordability) results in reducing food poverty by providing a possibility to refrigerate food and prolonging period for its usage and increasing the variability of food. Provision of energy also means possibility to use water pumps and water can be disinfected by i.e. boiling [24].

Even at basic level of energy provision, such as providing a 1kW (of renewable energy) per household, significant changes in the standard of life can be expected. Provision of light enables after nightfall activities for the inhabitants such as socializing or studying. It would in some case even ease the financial burden of households. It is often case that where it is affordable fossil fuels are used for lighting, while energy for heating is provided by collecting free materials.

FIGURE 5 CHILDREN AND WOMEN COLLECTING FIREWOOD (SOURCE: [19])

The decrease of demand for traditional biomass would decrease the rate of deforestation and thus simultaneously decrease Tajikistan's impact on climate change. It would also ease the burden of collecting the firewood and dung which is usually done by women and children. Allowing more time and better health to women and children, as it has been historically shown, leads to better overall education, and integration of women in various "money making" activities. Furthermore, many existing furnaces are from the Soviet era, and they were designed for fossil fuels resulting in very low efficiency when used now days with firewood and dung. Thus, shifting to another energy source would improve overall efficiency.

The provision of 3kW per household, or higher, has even greater impacts, as it further contributes to biodiversity conservation and carbon sinks preservation, and it enables usage of electricity for heating. While it is often mistaken and generalized that using electricity for heating is environmentally not preferred choice, in countries with abundant hydro sources that is not the case. Using renewable electricity for heating could decrease carbon footprint, preserve forest cover, improve health conditions by providing adequate warmth and improving the indoor air quality and it would serve as basis for storable food and disinfected water (See Annex 1 – A Scaling Up Exercises). By providing 3kW of renewable energy 1 million cubic meters of fuel wood would be preserved resulting in 1.8 million tons of carbon stored.

It is important to keep in mind that solving only one of the EFW issues would not provide long term solution to the poverty in Tajikistan. When searching for energy poverty solution all three pillars of EFW nexus need to be considered.

3 SOLUTIONS FOR THE ENERGY POOR IN TAJIKISTAN

Tajikistan suffers from deep and far-reaching aspects of poverty. Such cases, with a long present and persistent, cases of serious crises require systematic approach which does not focus on solving an individual problem, but rather on building basis to provide immediate relief, medium-term progress, and long-term complete recovery. Such an approach is the so called **early recovery**, which can be defined as:

multidimensional process, encompassing a number of actions or projects that begins in humanitarian settings, guided by development principles, catalyzing sustainable development opportunities. It focuses on restoring capacity of national institutions and local communities to recover from compound crises, and lay foundation for long-term development [13].

Most of the efforts on fixing the energy sector in Tajikistan have been set on hydroelectric projects as result of country's great hydro potential.

3.1 LONG-TERM PROSPECTS OF RENEWABLE ENERGY

Tajikistan has a potential with over 300 billion kWh per year, and is currently utilising bout 15 billion kWh [25]. Currently there is a significant push (by attracting foreign investors) to install up to 10,000 MWe of capacity.

Most of the projects were planned during the Soviet era, and have not made any progress since the independence of Tajikistan. The transmission and distribution grids are in serious need for improvement and there is inconsistent and/or nonexistent power supply in the remote areas.

The state owned power utility, Barqui Tojik, controls all elements of the power system in all regions of country except in GBAO where private owned Aga Khan's Pamir Energy operates. Barqui Tojik is vertical integrated and although some attempts have been made to unbundle it, in current circumstances, where the utility is operating with significant losses, the sole action of unbundling would not provide the desired effects.

However, most of the projects now planned are of a large-scale which by default will not provide immediate or medium-term solutions. Large-scale projects do have perspective, and could in the long-term provide basis for significant progress, but alone they are not sufficient without solutions for immediate relief.

3.2 SHORT- TERM POSSIBILITIES

3.2.1 HYDRO

Tajikistan's great hydro potential does not only offer opportunity for the large-scale hydroelectric but does provide significant potential for the small (mini and micro- see Table 2 for classification) hydro power plants (sHPPs). There are a number of sHPPs in operation that are often improvised and inefficient. They typically operate off-grid during winters and they are idle during summers.

TABLE 2 HPP CLASSIFICATION ACCORDING TO THE TAJIKISTAN'S MINISTRY OF ENERGY

	Class	mark	Power range
1	micro	µHPP	< 5 kW
2	mini	mHPP	5 -100 kW
3	small	sHPP	100 kW – 30 MW

Increase in number and efficiency of sHHPs in the clearly defined conditions would bring benefits to not only the power situation on the state level but, even more, it could benefit the local community and the industry. The sHPPs should be community based - owned and operated. They should work off-grid in the winter and on-grid in the summer to sell electricity to the grid and increase the communities' income. The amendment of the Energy Law from 2007 enables those activities.

However desirable it would be to sell the excess electricity to the grid, it is not likely that will happen in the short-term, as Tajikistan on the state level has excess electricity in the summer and has no adequate transmission network to be able to offer its electricity to the neighbouring countries.

Results of the basic scaling up exercise conducted (Annex 1 – A Scaling Up Exercises) show the significant potential benefits to the society from sHPPs projects. The aim of the exercise was to get the rough estimates of potential costs and benefits from providing the 3kW of electrical power to the most poverty stricken people of Tajikistan. It was estimated that the target group, most vulnerable people, would be represented by approximately 1 million people and, it was assumed that the average household size was 10 members. The results have shown that if local community participated in the building, operation and maintenance of the HPPs the benefits would be creation of 12000 jobs for the case of providing 3kW per household respectively.

TABLE 3 SCALING UP EXERCISE ASSUMPTIONS FOR SHPPS

Size of HPP	100	kW
Target population	1,000,0000	citizens
Household members	10	per household
Construction costs	100,000	US$/HPP
Percentage of local goods and services	50	%

TABLE 4 SCALING UP EXERCISE RESULTS FOR THE SHPPS

Number of targeted households	100,000
Aim [kW/household]	3
Nr. Of HPPS required	3,000
Total cost estimates [US$]	300,000,000
Return to economy [US$]	150,000,000
Jobs created	12,000

Furthermore, up to US$ 300 million would go back to the economy and could be used for the economic development, and if system of incentives was in place up to US$ 5,25 million per year would go back to local communities for poverty

reduction. Although hydro is considered to be main energy potential in Tajikistan, other energy sources, specifically, renewable, need also to be considered when assessing sustainable solutions for energy poverty.

3.2.2 SOLAR

Besides having excellent hydro potential, Tajikistan has also abundant solar availability, yet practically none is utilised. There is a good correlation between the most vulnerable areas and the good resource availability. The mountainous areas possess the largest potential of solar energy. There are 280-330 sunny days and the insolation varies from 3.5 to 4.5 kWh/m2/day in the worst month and up to 5.3 kWh/m2/day on the year average [25].

The experience gained so far has shown that usage of off-grid small photovoltaics (See Figure 6) can be more cost-effective than traditional usage of kerosene for lightning and some other minor electrical consumption. The technology available is mostly Chinese so it is inexpensive and close to get. Many people already save over a 1US$ per day by relying on photovoltaics rather than kerosene [26]. It provides the households with light after the night fall which is essential for families with children. However these solar applications have limited usage due to small batteries and small capacity and larger installations are too expensive for individuals to afford.

FIGURE 6 SMALL PHOTOVOLTAICS IN THE MOUNTAINS OF TAJIKISTAN (SOURCE: [16])

However, larger photovoltaics can be considered for use on larger, public objects, such as hospitals, schools and other aspects of social infrastructure. Because of the vast solar potential and availability of the cheap Chinese photovoltaics, implementation of bigger solar systems could play a role in reducing energy poverty in Tajikistan. With the price of approx 9600 US$ for total costs of installing a PV system of 1kWp, including 12V 100A batteries, those installations should definitely be considered. As majority of target group do not have funds to afford such installations, donors would play important role here. The total cost of providing 100 000 of the most vulnerable households with 1kWp of installed solar power would be 960 million US$, where, if local manpower is used for maintenance and installation, some 10% (or 96 million US$) could be directly supporting the local economy. Also, with the assumption that 20 jobs are created by installing 1MWp of photovoltaics, a total of 2000 jobs could be created.

Also, there is possibility to install simple solar cookers which could be used in the warm season and thus decrease the need for collecting firewood and dung for

cooking. However, problem with solar cookers, as has been observed [27], is that they can only be used during the daylight, and in the wintertime, when the insloation is weaker, the usage is very limited.

Further potential for usage of solar power shows in solar thermal systems, which can be used for domestic hot water and at times for heating systems. The issue with solar thermal collectors could be finding a suitable location for constructing them. Most of the houses in rural areas are of weaker build, and could not support such installations on the rooftops. Thus, as in the case of photovoltaics, the main target group would be larger public buildings and social infrastructure. The price of the 1000 l system (installation and equipment included) equals 1415 US$. This offers the possibility for jobs creation, for usage of local goods and services and for decrease of reliance on traditional biomass for domestic hot water and heating. Another potential weakness of using solar thermal systems in rural areas could be danger of freezing during the winter which could lead to breaking of pipes. Because of the aforementioned reasons, a further detailed study is recommended in order to provide more accurate estimation of usage potential for solar thermal applications in Tajikistan.

3.2.3 OTHER RENEWABLES

Although it is estimated that Tajikistan has potential of other resources – geothermal, wind and biogas [27], at the current conditions and state of technology, neither one of those renewables has real usage potential.

On most locations wind is not sufficient for utilization. Wind atlas shows that there is only one area with wind speeds of 5-6m/s at 30m height [25].

The geothermal resources are relatively small, and no extensive study was done in this field.

Although there could be some potential for biogas utilization, its usage is once again limited by the harsh wind conditions that would most likely have impact on winter production due to low temperatures.

4 RESULTS OF INCREASED ENERGY ACCESSIBILITY

It is well known that increase in energy accessibility and affordability directly impacts the overall quality of life [24]. Increase in use of energy reflects in health improvements by decreasing the indoor smoke from old wood furnaces, by providing adequate heat and by providing better conditions for producing, keeping and cooking food as well as sanitizing water. Karimov et.al. have found that the power of energy utilised per capita is in the range of 2.5kW in the rural areas. Out of that, only 0.2kW is of useful energy, while the rest is losses as the result of very low efficiency of cooking and heating stoves used, of about 5-10%.

In the Chapter 3, some options for sustainable increase in energy accessibility and affordability were discussed. It was shown that using small-scale renewables could be the fastest solution to the energy poverty case in Tajikistan. While in the long-term, utilization of large-scale hydro will likely play important role, in the short-

term those projects will not provide immediate benefits or the relief to the Tajik people.

Utilization of small-scale renewable, especially micro and small HPPs would ease the burden on small communities to collect traditional biomass and to buy kerosene for cooking and heating. Such small installations require little, if any, international products, and using local goods and services would result in returning the money to the local economy thus inducing progress. Jobs would be created and people, especially women and children, would have more time for studying and "money making" activities as the result of decreased need for firewood and dung collection. Availability of lighting would allow better quality of life and longer hours for various indoor activities.

The reduced need for firewood would decrease the damage on local ecosystems. It would reduce the already devastating rate of deforestation which, on the slopes of mountainous Tajikistan, results in highly increased susceptibility to soil erosion, salinization and in the end desertification. Such land cannot be used for agricultural activities nor does it even offer possibility for reforestation. Decrease of dung collection would leave more dung to be used for fertilizing the agricultural land which would then have higher yields. Overall it is clear that turning to the small-scale renewables would improve the overall quality of life while decreasing the rate of energy poverty in Tajikistan.

It has to be noted that further study is required to analyze the impact of other measures to decrease energy poverty such as increasing energy affordability. For this analysis specific rural conditions have to be taken into account where i.e. collection of wood does not have direct share in household expenditures as it is free of cost. In such cases the opportunity costs should be considered and the impact on potentially lover households' income as results of women and children being in poorer health and spending more time on firewood collection etc. Also, impact of tariff increase on energy poverty from the aspect of both affordability and accessibility should be addressed. Would the number of households unable to afford energy increase with increased tariffs? Would the rural households without access to electricity remain unaffected by the tariff increase - as without access they have nothing to pay for, or would they be affected by slower rate of increase in access as the costs of connection would also increase?

Furthermore, there is a possibility that, despite the increase from hydro production - especially large scale, the overall access will decrease as result of network deterioration. However, no study has been done yet to get the realistic estimates of access decrease as result of network deterioration and of lacking network expansion. If it proves to be the case that despite introduction of large-scale hydro, the rate access is decreasing, this could play an important role in supporting the case for introducing small renewable on the large-scale. Thus, it is highly recommended this issue to be addressed soon.

Another potential issue to be addressed is the question of profitability of renewable in Tajikistan. Could the increase in renwables bring direct profit to Tajikistan, without subsidies and other forms of support? Or will it remain solely as the energy poverty reduction measure and stimulus for local development?

All these, and more, questions need to be addressed urgently so that timely and right actions to decrease and eventually eradicate energy poverty could be done.

5 CONCLUSION

Energy poverty may be difficult to universally define, but despite the differences in various cases it is universally clear that there are many people worldwide that suffer from some aspect of energy poverty. This article has given the overview of the energy poverty situation in specific case of the Republic of Tajikistan.

Tajikistan suffers from acute case of energy poverty, where people lack both access to energy and the ability to afford it. As the winters are harsh and cold, people search for alternatives to conventional sources of energy resulting in land degradation, deforestation and poor water quality and bad health condition. The opportunities show in the vast renewable resources, especially hydro. While there is a lot of effort to build large-scale hydro plants, until recently less attention has been put on the opportunities arising from the utilisation of small-scale renwables. Providing 3kW per household for the most vulnerable group would result in significant benefits that would show, not only in the relief for the energy poverty stricken households, but which would show in the wide scope of benefits. This scope would encompass a range of possible positive outcomes in society, environment and economy. The action needs to be done urgently. The risk of losing the forest cover, the fertility of the land and in the end human lives is too great not to take immediate action. The issue of energy poverty cannot, and should not, be addressed separately from the environmental or economic factor, as it is not likely it would provide a viable long-term solution. To provide a base for sustainable long-term eradication of energy poverty, an immediate sustainable approach has to be chosen.

In the immediate to medium-term, there seem to be no viable options for eradicating energy poverty in Tajikistan - while at the same time taking care of environment and supporting the local industry-, other than small scale renewables, most significantly hydro. As there is evident lack of reliable data on key issues related to energy poverty in Tajikistan, a further study is highly recommended to provide solid and well argued background for further action. It is recommended that Tajikistan strategically chooses small-scale renewable as one of key options for stabilization and growth of energy supply, with clear targets set - subject to further study.

Tajikistan is a country with considerable renewable energy potential, a potential that could represent the driving force in its growth and development. However, unless a timely and sustainable action is carried out, the environmental degradation followed by energy poverty and financial instability is likely to continue for the worse.

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ANNEX 1 – A SCALING UP EXERCISES

The figures:

Population of Tajikistan	7.5 M
Living in rural areas	70%
Living in poverty	50%
Average number of household members	10
Number of households living in poverty	375,000
Average price of kWh for households	US $ 0.02

6.1 PROVIDING 3KW PER HOUSEHOLD TO 1 MILLION OF PEOPLE

i) 1 million of people = 100,000 households

ii) to provide 3 kW per household from community based s/m HPP =

a. 100,000 x 3 kW = 300,000 kW = 300 MW
(this is less than 1% of total hydro power potential in the country)

iii) to standardize s/m HPP @ 33kW at average costs of $ 15,000.00
@ 60 kW at average costs of $ 30,000.00
@ 100 kW at average costs of $ 100,000.00
@ 160 kW at average costs of $ 130,000.00

iv) at an average size of 100 kW, some 3000 m/s HPP units are required

v) investment costs: 3000 x US$ 200,000 = 600,000,000

i. = 600 million US$

vi) to have at least 50% input of local goods and services related to HPP construction

a. 50% of iv) = US$ 300 M, which goes back to the economy –**for economic development**

vii) HPPs are operated and maintained by communities, **which creates employment for some 12000 people in rural areas only (**according to 40 jobs per 1MW)

viii) if assumed that average per capita consumption equals 1 m3 of fuel wood per annum = 1m3*1,000,000= 1,000,000m3 fuel wood/annum for cooking and heating ,1,000,000 m3 fuel wood/annum could be saved from deforestation by installing electrical stoves and electrical heating

ix) Trees absorb 1,8 tCO2/m3 => 1,000,000m3 x 1,8 tCO2/m3= 1,8MtCO2 emission in carbon sinks if deforestation is prevented by using electricity from s/m HPPs for cooking and heating

x) Replacing indoor wood and dung cooking and heating with electrical cookers decreases level of harmful substances in the air known for having adverse health impacts for inhabitants of such households specifically on women and children

xi) HPPs work of-grid during winter and communities pay agreed price for electricity

xii) Where feasible, HPPs work on-grid during summer and sell electricity to Barki Tajik through an appropriate intermediary

On-grid time: 3500 h/a

On-grid price: US$ 0.03 (incentivized at US cent 0.01)

On-grid power: 150 MW

Annual amount for incentives:

0.01x3500x300,000 = 5,25 M US$/year goes back to communities

- for poverty reduction